ELECTRONIC EQUIPMENT COOLING DEVICE

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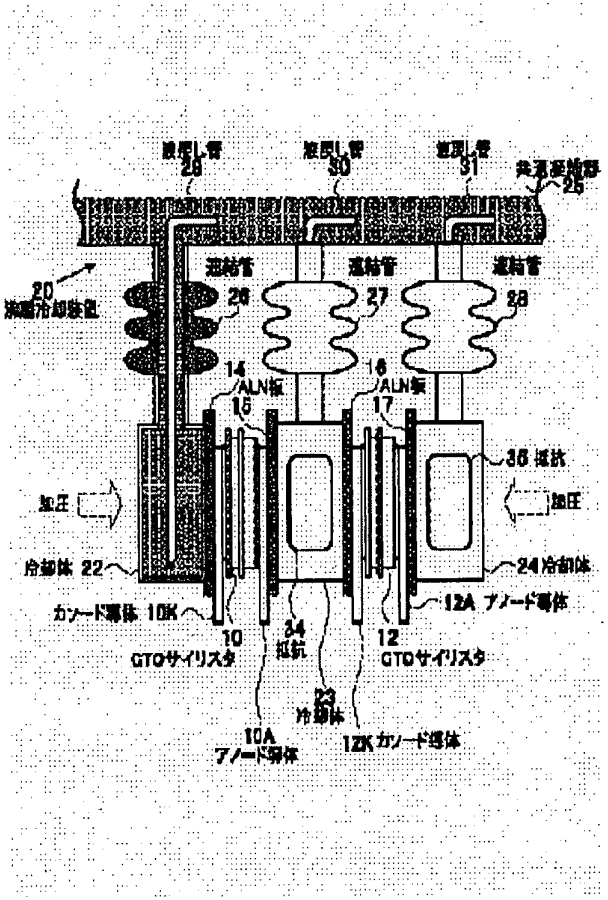
Abstract of **JP2001326310**

PROBLEM TO BE SOLVED: To extremely reduce the amount of generated heat of a resistor that is radiated into the internal space of an enclosure.
SOLUTION: A semiconductor stack is composed by alternately laminating flat power semiconductor devices 10 and 12, and cooling bodies 22-24. A common condenser 25 condenses and liquefies a refrigerant that is vaporized by cooling bodies 22-24. Connection pipes 26-28 guide the refrigerant that is vaporized by the cooling bodies 22-24 to the common condenser 25. Liquid-returning pipes 29-31 allow the refrigerant that is condensed and liquefied by the common condenser 25 to flow back to the cooling bodies 22-24. Resistors 33-35 are provided so that they are in contact with the side surface of the cooling bodies 22-24 for forced cooling, thus extremely reducing the amount of heat that is discharged from the resistors 33-35 to the internal space of the enclosure.


逆阻止管
29
逆阻止管
30
逆阻止管
31
共通逆阻止管
25
通流管
通流管
通流管
20
冷却装置
26
27
28
14
ALN板
15
16
ALN板
17
36 抵抗
加圧
加圧
冷却体 22
24 冷却体
カソード導体 10K
12A アノード導体
10
GTOサイリスタ
34
抵抗
12
GTOサイリスタ
23
冷却体
10A
アノード導体
12K カソード導体

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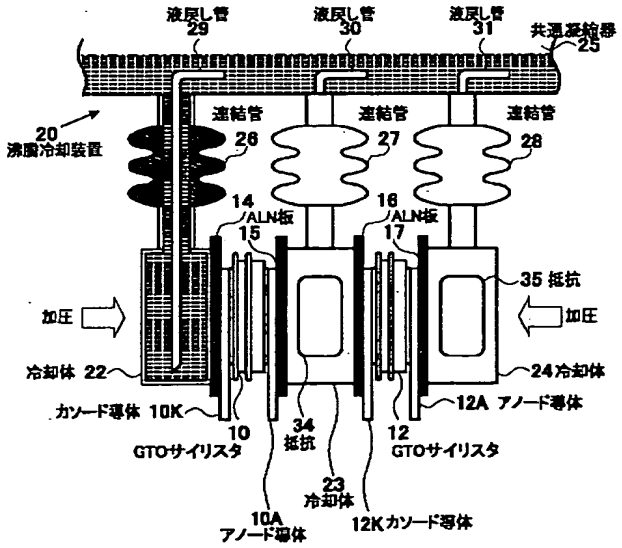
(54)【発明の名称】　電子機器冷却装置

(57)【要約】
【目的】　筐体内部空間に放出される抵抗器の発生熱量を極力低減する。
【構成】　半導体スタックは、平形パワー半導体素子１０，１２と冷却体２２～２４を交互に積層することによって構成される。共通凝縮器２５は、冷却体２２～２４で気化された冷媒を凝縮液化する。連結管２６～２８は、冷却体２２～２４で気化された冷媒を共通凝縮器２５に導く。液戻し管２９～３１は、共通凝縮器２５で凝縮液化された冷媒を冷却体２２～２４に還流する。抵抗器３３～３５は、冷却体２２～２４の側面に接触するように設けられ、強制的に冷却される。これによって、抵抗器３３～３５から筐体内部空間に放出される熱量は極力低減されるようになる。



【特許請求の範囲】
【請求項１】　半導体素子手段の両側に接触するように冷却手段を設けて前記半導体素子手段を冷却するように構成された電子機器冷却装置において、
抵抗手段を前記冷却手段と接触するように設けたことを特徴とする電子機器冷却装置。
【請求項２】　半導体素子手段とこの半導体素子手段を冷却する冷却手段とを交互に積層することによって構成された半導体スタック手段と、
前記冷却手段で気化された冷媒を凝縮液化する凝縮手段と、
前記冷却手段で気化された前記冷媒を前記凝縮手段に導く連結管手段と、
前記凝縮手段で凝縮液化された前記冷媒を前記冷却手段に還流する液戻し管手段とから構成される電子機器冷却装置において、
抵抗手段を前記冷却手段と接触するように設けたことを特徴とする電子機器冷却装置。
【請求項３】　請求項２において、
前記冷却手段のそれぞれが冷媒を貯留し、前記連結管手段及び前記液戻し管手段によって個別に前記凝縮液化手段に接続されていることを特徴とする電子機器冷却装置。
【請求項４】　請求項２又は３において、
前記抵抗手段を前記冷却手段と前記半導体素子手段との接触する面以外の前記冷却手段の少なくとも一つの側面に接触するように設けたことを特徴とする電子機器冷却装置。
【請求項５】　請求項１、２、３又は４において、
前記冷却手段は銅又は銅合金で構成されたことを特徴とする電子機器冷却装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電鉄用として地上に設置される電力変換装置等の電子機器を冷却する電子機器冷却装置に係り、特に半導体素子を沸騰冷却方式の冷却体に接触させて冷却する電子機器冷却装置に関する。
【０００２】
【従来の技術】従来、電鉄用として地上に設置される電力変換装置は、パワー半導体素子、抵抗器やコンデンサなどの補助回路用電子機器で構成され、雨水等が浸入しない様に密閉された筐体内に収納されている。パワー半導体素子は、通電中に接合部温度が所定温度を超えると熱破壊してその機能を喪失するので、接合部温度が所定温度よりも大きくならないように沸騰冷却方式によって強制的に冷却されている。一方、補助回路用電子機器の中の特に抵抗器には、自冷型のものが通常使用されており、筐体内部で発生した他の熱量（導体が発生する熱量など）と共に筐体壁面を介して、空気と自冷熱交換するように構成されている。すなわち、抵抗器は筐体床部に設置され、抵抗器で発生した熱量は筐体内部に自冷放熱される。筐体内部に自冷放熱された抵抗器の熱量は、筐体壁面を介して筐体外部の空気の自然対流によって自冷熱交換される。
【０００３】
【発明が解決しようとする課題】上述のように従来は、筐体内部の抵抗器で発生する熱量を全て筐体内部空間に放出していた。従って、筐体内部で発生する熱量（抵抗器から発生する熱量、導体から発生する熱量など）を筐体外部の空気と自然対流で熱交換させるために、筐体の表面積を大きくせざるをえず、不必要に筐体容積が大きくなり、それに伴って設置面積も大きくしなければならないという問題があった。
【０００４】本発明は、上述の点に鑑みてなされたものであり、筐体内部空間に放出される抵抗器の発生熱量を極力低減することのできる電子機器冷却装置を提供することを目的とする。
【０００５】
【課題を解決するための手段】請求項１に記載された電子機器冷却装置の発明は、半導体素子手段の両側に接触するように冷却手段を設けて前記半導体素子手段を冷却するように構成された電子機器冷却装置において、抵抗手段を前記冷却手段と接触するように設けたものである。通常、電子機器冷却装置は、通電中に接合部温度が所定温度を超えると熱破壊してその機能を喪失しないように半導体素子手段をその両側に設けられた冷却手段で強制的に冷却し、抵抗手段などのような熱破壊しない電子機器を自冷冷却方式で冷却している。この発明では、半導体素子手段に接触するように設けられた冷却手段の側面部はその冷却能力が低く、使われていなかった点に着目し、冷却手段の側面部に抵抗手段を接触するように設けて強制的に冷却するようにした。これによって、抵抗手段から筐体内部空間に放出される熱量を極力低減することができる。
【０００６】請求項２に記載された電子機器冷却装置の発明は、半導体素子手段とこの半導体素子手段を冷却する冷却手段とを交互に積層することによって構成された半導体スタック手段と、前記冷却手段で気化された冷媒を凝縮液化する凝縮手段と、前記冷却手段で気化された前記冷媒を前記凝縮手段に導く連結管手段と、前記凝縮手段で凝縮液化された前記冷媒を前記冷却手段に還流する液戻し管手段とから構成される電子機器冷却装置において、抵抗手段を前記冷却手段と接触するように設けたものである。これは、半導体素子手段と冷却手段とが交互に積層された半導体スタック手段を凝縮手段、連結管手段及び液戻し管手段からなる沸騰冷却装置で冷却する電子機器冷却装置に関するものであり、抵抗手段を冷却手段の側面部に接触するように設けて強制的に冷却するようにした点は請求項１と同じである。

【０００７】請求項３に記載された電子機器冷却装置の発明は、請求項２において、前記冷却手段のそれぞれが冷媒を貯留し、前記連結管手段及び前記液戻し管手段によって個別に前記凝縮液化手段に接続されているものである。沸騰冷却装置の冷却方式には、浸漬式の一括冷却方式と個別冷却方式があるが、これは、個別冷却方式の電子機器冷却装置について限定している。

【０００８】請求項４に記載された電子機器冷却装置の発明は、請求項２又は３において、前記抵抗手段を前記冷却手段と前記半導体素子手段との接触する面以外の前記冷却手段の少なくとも一つの側面に接触するように設けたものである。通常、半導体スタック手段を構成する冷却手段は直方体形状をしており、その対抗する両面又は片面に半導体素子手段が加圧接触している。直方体は通常６面を有し、半導体素子手段との加圧接触にはそのうちの２面が少なくとも使用されている。従って、残りの４面には連結管手段や液戻り管手段が設けられたり、何も設けられていなかったりするので、この４面のうちの少なくとも一つの側面に抵抗手段を接触するように設けることによって、抵抗手段を効率的に冷却するようにした。

【０００９】請求項５に記載された電子機器冷却装置の発明は、請求項１、２、３又は４において、前記冷却手段を銅又は銅合金で構成したものである。冷却手段は、コスト面及び製造技術面を優先して鉄やステンレスで構成する場合が多いが、耐真空度を上げるために厚い材料で構成されている。従って、材料が厚い分、熱伝導性が悪く、抵抗手段を冷却体の側面に設けても、冷却効率が悪かった。そこで、冷却手段を銅又は銅合金製で構成することによって、良好な熱伝導と、沸騰冷却効率の向上が望め、抵抗手段を効率良く冷却することができる。

【００１０】

【発明の実施の形態】以下、本発明の実施の形態を添付図面に従って説明する。図１は、沸騰冷却方式にてパワー半導体素子及び抵抗器を冷却するように構成された電子機器冷却装置の概略構成を示す図である。図２は、図１の電子機器冷却装置を右側から見た側面図であり、共通凝縮器を省略して示してある。沸騰冷却方式には浸漬式の一括冷却方式と個別冷却方式があるが、この実施の形態では、個別冷却方式の電子機器冷却装置について説明する。個別冷却方式は、内部に低沸点の冷媒を封入した冷却体と放熱凝縮器との間を個別に連結管及び液戻し管で接続したものである。なお、沸騰冷却方式の原理は周知であり、通電によって半導体デバイス及び抵抗器に発生した熱は冷却体に満たした冷媒に熱伝達される。一方、冷媒は熱流束の増加に伴い核沸騰して気化され、冷却体から放熱凝縮器に移動した上で気化時に得た潜熱を放出して凝縮、液化した後に、冷却体に還流するように気化と凝縮を繰り返してパワー半導体素子及び抵抗器を冷却する。

【００１１】図では、サイリスタ又はダイオードなどの２個の平形パワー半導体素子１０，１２を絶縁板となる窒化アルミニウム（ＡＬＮ）板１４～１７を介して沸騰冷却装置２０の冷却体２２～２４に加圧接触させることによって、冷却体２２、ＡＬＮ板１４、平形パワー半導体素子１０、ＡＬＮ板１５、冷却体２３、ＡＬＮ板１６、平形パワー半導体素子１２、ＡＬＮ板１７、冷却体２４からなる積層体、すなわち半導体スタックを構成している。図１において、冷却体２２の右側側面はＡＬＮ板１４を介して平形パワー半導体素子１０のカソード導体１０Ｋ側に、冷却体２２の左側側面は加圧接触部材（図示せず）に、冷却体２３の左側面はＡＬＮ板１５を介して平形パワー半導体素子１０のアノード導体１０Ａに、冷却体２３の右側面はＡＬＮ板１６を介して平形パワー半導体素子１２のカソード導体１２Ｋに、冷却体２４の左側側面はＡＬＮ板１７を介して平形パワー半導体素子１２のアノード導体１２Ａに、冷却体２４の右側側面は加圧接触部材（図示せず）にそれぞれ接している。一方、抵抗器３４，３５は、図１では冷却体２３，２４の手前側側面に、図２では冷却体２３，２４の左側側面にそれぞれビス留めされている。なお、冷却体２２の側面にも抵抗器３３がビス留めされているが、冷却体２２についてはその断面構造が示されているので、抵抗器３３については図示を省略してある。

【００１２】沸騰冷却装置２０は、共通凝縮器２５、ベローズ気相管を含む連結管２６～２８、液戻し管２９～３１及び冷却体２２～２４から構成される。共通凝縮器２５は、大気との間で熱交換を行って気化した冷媒を凝縮させて液化し、内部に貯留するものである。図では、共通凝縮器２５に内蔵されるラジエターなどについては省略してある。冷却体２２～２４は、銅又は銅合金やアルミニウムなどの金属ブロックを機械加工により箱型に削り出し、その内部に放熱用のフィンや仕切り板を多数有し、そこに冷媒を貯留するような構成になっている。この冷媒にはエチレングリコール水溶液などの導電性冷媒が使用される。従って、平形パワー半導体素子１０，１２と冷却体２２～２４との間には、絶縁用のＡＬＮ板１４～１７が挿入されている。冷媒にフロンやフロロカーボンなどの絶縁性冷媒を使用する場合には、このＡＬＮ板１４～１７は省略することができる。

【００１３】冷却体２２～２４と共通凝縮器２５は、連結管２６～２８及び液戻し管２９～３１によって接続されている。連結管２６～２８と液戻し管２９～３１は、２重管構造となっており、冷却体２２～２４で加熱沸騰して気化した冷媒は外側管の連結管２６～２８と内側管の液戻し管２９～３１との間を上昇し、共通凝縮器２５に導かれる。連結管２６～２８の一部に設けられたベローズ気相管は、温度変化による各部の膨張・収縮を吸収するものである。なお、ベローズ気相管以外にも、冷却体２２～２４と共通凝縮器２５との間を絶縁するための

絶縁管を連結管２６～２８の途中に設ける場合がある。なお、図では、冷却体２２及び連結管２６に関してはその断面構造が示されており、他の冷却体２３，２４及び連結管２７，２８も同様な構造になっている。

【００１４】平形パワー半導体素子１０，１２からの発熱はＡＬＮ板１４～１７を介して冷却体２２～２４に伝達し、抵抗器３３～３５からの発熱は直接冷却体２２～２４に伝達する。冷却体２２～２４では、これらの熱によって冷媒が沸騰して気化する。気化した冷媒は、外側管の連結管２６～２８と内側管の液戻し管２９～３１との間を上昇して共通凝縮器２５に導かれ、そこで液化される。液化された冷媒は、共通凝縮器２５に一時的に貯留し、液戻し管２９～３１を介して冷却体２２～２４に落下して戻るようになっている。このようにして、沸騰冷却装置２０は、冷却体３３～３５で冷媒を沸騰させて気化し、共通凝縮器２５でそれを液化させることによって、平形パワー半導体素子１０，１２及び抵抗器３３～３５の温度上昇を抑制している。

【００１５】なお、この実施の形態では、冷却体２２～２４を銅又は銅合金で構成している。従来、沸騰冷却装置２０を構成する冷却体は材料の制約がないことからコスト面及び製造技術面を優先して鉄やステンレスで構成していた。そして、沸騰冷却装置２０の耐真空度を上げるために冷却体の材料を厚くしていた。従って、材料が厚い分、熱伝導性が悪く、抵抗器を冷却体の側面に設けても、冷却効率が悪く、結果として抵抗器の容量を大きくしなければならなかった。これに対して、銅又は銅合金製の冷却体は、良好な熱伝導を示すため沸騰冷却効率がよくなり、抵抗器３３～３５で発生した熱量は、銅又は銅合金製の冷却体を介して冷却体内部の冷媒に容易に伝達し、そこで放熱及び沸騰冷却されるようになる。これによって、抵抗器３３～３５で発生した熱量のうち筐体内部に拡散する成分を大幅に低減することができ、結果として筐体表面積の削減、電子機器全体の小型化を実現することができる。また、従来のように抵抗器を自冷冷却方式で使用していた場合には、抵抗器容量＝発生熱量×４～５であり、抵抗器の実際の発生熱量に比べて大きな抵抗器を使用しなければならなかった。それが、この発明のように抵抗器を自冷冷却方式から強制冷却（沸騰冷却）方式にしたことで、抵抗器容量＝発生熱量となり、抵抗器自体を小型化することができ、その組み立て性の向上も図ることができるようになった。

【００１６】なお、上述の実施の形態では、スタック構造体として、平形パワー半導体素子と冷却体の積層体から構成される半導体スタックを例に説明したが、これに限らず、これ以外の半導体スタック、ダイオード整流器スタック、半導体スイッチスタックなどの各スタックを構成する電子機器冷却装置にも同様に適用することができる。また、上述の実施の形態では、発熱体を個別に冷却する個別冷却方式を例に説明したが、一括冷却方式の場合にも同様に適用することができる。上述の実施の形態では、半導体スタックが２個の平形パワー半導体素子１０，１２と３個の冷却体２２～２４によって構成された場合について説明したが、これ以上の個数の平形パワー半導体素子及び冷却体から構成される半導体スタックにも同様に適用することができる。上述の実施の形態では、連結管を気相管と戻し管の２重管構造の場合を例に説明したが、気相管と戻し管を別個に配置したものにも同様に適用することができる。

【００１７】上述の実施の形態では、抵抗器を冷却体の片側側面に設ける場合について説明したが、半導体素子と接触する箇所以外であれば、冷却体の両側側面や下側、上側などに抵抗器を設けてもよい。さらに、上述の実施の形態では、半導体スタックを構成する冷却体に抵抗器を設ける場合について説明したが、半導体スタックを構成しない冷却体すなわち抵抗器だけを冷却するための専用の冷却体を別途設け、それを連結管及び液戻し管で共通凝縮器２５に接続するようにしてもよい。この場合、冷却体は加圧接触されるスタック構成をとらないため、材料を比較的薄くするができ冷却効率を優先させることができる。

【００１８】

【発明の効果】本発明の電子機器冷却装置によれば、筐体内部空間に放出される抵抗器の発生熱量を極力低減することができるという効果がある。

【図面の簡単な説明】

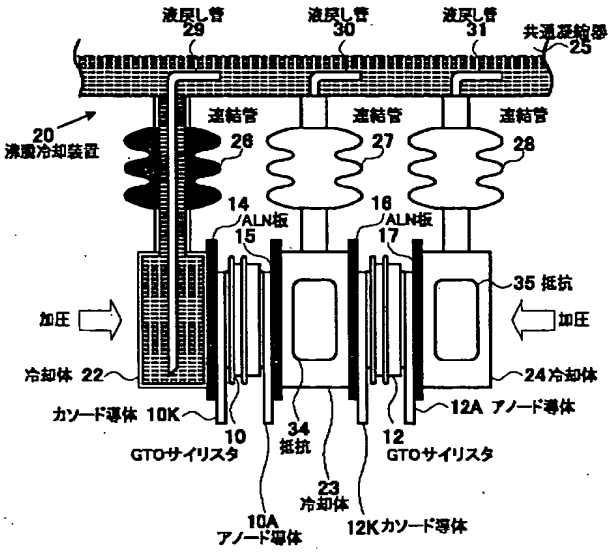
【図１】　沸騰冷却方式にてパワー半導体素子及び抵抗器を冷却するように構成された電子機器冷却装置の概略構成を示す図

【図２】　図１の一部を図面中の右側から見た側面図

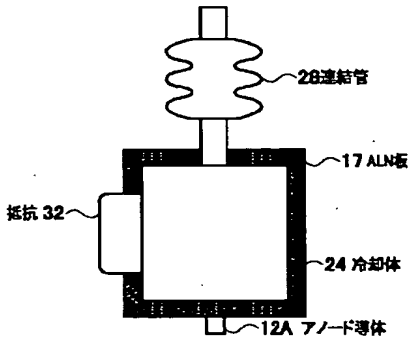
【符号の説明】

１０，１２	平形パワー半導体素子
１４～１７	窒化アルミニウム板
２０	沸騰冷却装置
２２～２４	冷却体
２５	共通凝縮器
２６～２８	連結管
２９～３１	液戻し管
３３～３５	抵抗器

【図１】



【図２】



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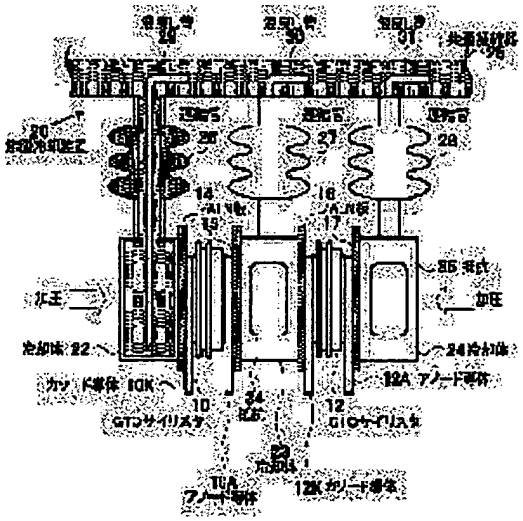
(72)Inventor : HINO KOJI

(54) ELECTRONIC EQUIPMENT COOLING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To extremely reduce the amount of generated heat of a resistor that is radiated into the internal space of an enclosure.

SOLUTION: A semiconductor stack is composed by alternately laminating flat power semiconductor devices 10 and 12, and cooling bodies 22-24. A common condenser 25 condenses and liquefies a refrigerant that is vaporized by cooling bodies 22-24. Connection pipes 26-28 guide the refrigerant that is vaporized by the cooling bodies 22-24 to the common condenser 25. Liquid-returning pipes 29-31 allow the refrigerant that is condensed and liquefied by the common condenser 25 to flow back to the cooling bodies 22-24. Resistors 33-35 are provided so that they are in contact with the side surface of the cooling bodies 22-24 for forced cooling, thus extremely reducing the amount of heat that is discharged from the resistors 33-35 to the internal space of the enclosure.



LEGAL STATUS

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[Date of extinction of right]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] An electronic equipment cooling system characterized by having established a cooling means, and establishing a resistance means in an electronic equipment cooling system constituted so that said semiconductor device means might be cooled so that said cooling means may be contacted so that both sides of a semiconductor device means may be contacted.
[Claim 2] A semiconductor stack means constituted by carrying out the laminating of a semiconductor device means and a cooling means to cool this semiconductor device means, by turns, A condensation means to condensate-ize a refrigerant evaporated with said cooling means, and an interconnecting-tube means to lead said refrigerant evaporated with said cooling means to said condensation means, An electronic equipment cooling system characterized by establishing a resistance means in an electronic equipment cooling system which consists of liquid return pipe means to flow back for said cooling means, in said refrigerant condensate-ized with said condensation means so that said cooling means may be contacted.
[Claim 3] An electronic equipment cooling system characterized by for each of said cooling means storing a refrigerant and connecting it to said condensate-ized means according to an individual in claim 2 by said interconnecting-tube means and said liquid return pipe means.
[Claim 4] An electronic equipment cooling system characterized by establishing said resistance means in claim 2 or 3 so that at least one side of said cooling means other than a field of said cooling means and said semiconductor device means which contacts may be contacted.
[Claim 5] It is the electronic equipment cooling system characterized by said cooling means consisting of copper or a copper alloy in claims 1, 2, and 3 or 4.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the electronic equipment cooling system which the electronic equipment cooling system which cools electronic equipment, such as a power converter installed on the ground as an object for electric railroads, is started, especially a semiconductor device is contacted on the cooling object of ebullition cooling system, and is cooled.
[0002]
[Description of the Prior Art] Conventionally, the power converter installed on the ground as an object for electric railroads consists of electronic equipment for supplemental circuits, such as a power semiconductor device, a resistor, and a capacitor, and is contained in the case with which storm sewage etc. does not permeate and which was sealed like. Since the thermal runaway of the power semiconductor device will be carried out and it will lose the function if junction temperature exceeds predetermined temperature during energization, it is compulsorily cooled by ebullition cooling system so that junction temperature may not become larger than predetermined temperature. On the other hand, the thing of a natural-convection-cooling mold is usually used especially for the resistor, and it is constituted so that natural-convection-cooling heat exchange may be carried out to air through a case wall surface with other quantity of heat in the electronic equipment for supplemental circuits (quantity of heat which a conductor generates) generated inside the case. That is, a resistor is installed in a case floor and natural-convection-cooling thermolysis of the quantity of heat generated by the resistor is carried out inside a case. Natural-convection-cooling heat exchange of the quantity of heat of the resistor by which natural-convection-cooling thermolysis was carried out is carried out to the interior of a case by the free convection of the air of the case exterior through a case wall surface.
[0003]
[Problem(s) to be Solved by the Invention] Conventionally, all the quantity of heat generated by the resistor inside a case was emitted to the case building envelope as mentioned above. in order [therefore,] to carry out heat exchange of the quantity of heat (quantity of heat generated from a resistor, quantity of heat generated from a conductor) generated inside a case by the air and the free convection of the case exterior -- the surface area of a case -- large -- not carrying out -- it did not obtain, but case capacity became large superfluously, and there was a problem that installation area also had to be enlarged in connection with it.
[0004] This invention is made in view of an above-mentioned point, and aims at offering the electronic equipment cooling system which can reduce the generating quantity of heat of the resistor emitted to a case building envelope as much as possible.
[0005]
[Means for Solving the Problem] Invention of an electronic equipment cooling system indicated by claim 1 establishes a cooling means, and it establishes a resistance means in an electronic equipment cooling system constituted so that said semiconductor device means might be cooled so that said cooling means may be contacted, so that both sides of a semiconductor device means may be contacted. Usually, it would cool compulsorily with a cooling means by which a semiconductor device means was established by the both sides so that a thermal runaway might be carried out and the function might not be lost, and an electronic equipment cooling system will have cooled electronic equipment which does not carry out a thermal runaway, such as a resistance means, with natural-convection-cooling cooling system, if junction temperature exceeds predetermined temperature during energization. In this invention, that refrigeration capacity of a lateral portion of a cooling means established so that a semiconductor device means might be contacted was low, and it is prepared so that a lateral portion of a cooling means may be contacted in a resistance means paying attention to a point which was not used, and it was cooled compulsorily. By this, quantity of heat emitted to a case

building envelope from a resistance means can be reduced as much as possible.
[0006] Invention of an electronic equipment cooling system indicated by claim 2 A semiconductor stack means constituted by carrying out the laminating of a semiconductor device means and a cooling means to cool this semiconductor device means, by turns, A condensation means to condensate-ize a refrigerant evaporated with said cooling means, and an interconnecting-tube means to lead said refrigerant evaporated with said cooling means to said condensation means, In an electronic equipment cooling system which consists of liquid return pipe means to flow back for said cooling means, in said refrigerant condensate-ized with said condensation means, a resistance means is established so that said cooling means may be contacted. A point which this establishes a resistance means about an electronic equipment cooling system which cools a semiconductor stack means by which the laminating of a semiconductor device means and the cooling means was carried out by turns, with an ebullition cooling system which consists of a condensation means, an interconnecting-tube means, and a liquid return pipe means so that a lateral portion of a cooling means may be contacted, and was cooled compulsorily is the same as claim 1.
[0007] Invention of an electronic equipment cooling system indicated by claim 3 stores a refrigerant in claim 2, and each of said cooling means is connected to said condensate-ized means according to an individual by said interconnecting-tube means and said liquid return pipe means. Although there are package cooling system and individual cooling system of an immersion type among the cooling system of an ebullition cooling system, this limits about an electronic equipment cooling system of individual cooling system.
[0008] In claim 2 or 3, invention of an electronic equipment cooling system indicated by claim 4 establishes said resistance means so that at least one side of said cooling means other than a field of said cooling means and said semiconductor device means which contacts may be contacted. Usually, a cooling means to constitute a semiconductor stack means is carrying out a rectangular parallelepiped configuration, and a semiconductor device means is carrying out pressurization contact at the both sides or one side which opposes. A rectangular parallelepiped usually has the 6th page and the 2nd of pages [them] is used for pressurization contact for a semiconductor device means at least. Therefore, since neither an interconnecting-tube means nor a liquid return-pipe means was formed in the 4th remaining page or nothing was prepared, a resistance means was efficiently cooled by preparing so that at least one of this 4th page may be contacted in a resistance means.
[0009] Invention of an electronic equipment cooling system indicated by claim 5 constitutes said cooling means from copper or a copper alloy in claims 1, 2, and 3 or 4. Although a cooling means gives priority to a cost side and a manufacturing-technology side and constitutes them from iron or stainless steel in many cases, in order to raise a degree of vacuum-proof, it consists of thick materials. Therefore, a part with a thick material and thermal conductivity were bad, and cooling effectiveness was bad even if it formed a resistance means in the side of a cooling object. Then, by constituting a cooling means from copper or a product made from a copper alloy, improvement in vapor cooling effectiveness can be wished good heat conduction, and a resistance means can be cooled efficiently.
[0010]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained according to an accompanying drawing. Drawing 1 is drawing showing the outline configuration of the electronic equipment cooling system constituted so that a power semiconductor device and a resistor might be cooled with ebullition cooling system. Drawing 2 is the side elevation which looked at the electronic equipment cooling system of drawing 1 from right-hand side, omits a common condenser and is shown. Although there are the package cooling system and individual cooling system of an immersion type among the ebullition cooling system, the gestalt of this operation explains the electronic equipment cooling system of individual cooling system. Individual cooling system connects between the cooling objects and thermolysis condensers which enclosed the refrigerant of a low-boiling point with the interior according to an individual with an interconnecting tube and a liquid return pipe. In addition, the principle of ebullition cooling system is common knowledge, and heat transfer of the heat generated to the semiconductor device and the resistor by energization is carried out to the refrigerant filled on the cooling object. After emitting the latent heat obtained at the time of evaporation after carrying out nucleate boiling, being evaporated with the increment in thermal flux and a refrigerant's moving to a thermolysis condenser from a cooling object on the other hand and condensing and liquefying, evaporation and condensation are repeated and a power semiconductor device and a resistor are cooled so that it may flow back on a cooling object.
[0011] By making the cooling objects 22-24 of the ebullition cooling system 20 carry out pressurization contact of the two common form power semiconductor devices, a thyristor or diode, 10 and 12 by a diagram through the alumimium nitride (ALN) boards 14-17 used as an electric insulating plate The layered product which consists of the cooling object 22, the ALN board 14, the common form power semiconductor device 10, the ALN board 15, the cooling object 23, the ALN board 16, the common form power semiconductor device 12, an ALN board 17, and a cooling object 24, i.e., a

semiconductor stack, is constituted. drawing 1 -- setting -- the right-hand side side of the cooling object 22 -- the ALN board 14 -- minding -- the cathode of the common form power semiconductor device 10 -- a conductor -- to the 10K side the left-hand side side of the cooling object 22 -- a pressurization contact-carrying member (not shown) -- the left lateral of the cooling object 23 -- the ALN board 15 -- minding -- the anode of the common form power semiconductor device 10 -- a conductor -- to 10A the right lateral of the cooling object 23 -- the ALN board 16 -- minding -- the cathode of the common form power semiconductor device 12 -- a conductor -- to 12K the left-hand side side of the cooling object 24 -- the ALN board 17 -- minding -- the anode of the common form power semiconductor device 12 -- a conductor -- the right-hand side side of the cooling object 24 is in contact with the pressurization contact-carrying member (not shown) at 12A, respectively. On the other hand, resistors 34 and 35 are made into the near-side side of the cooling objects 23 and 24 by drawing 1 , and the bis-stop is carried out to the left-hand side side of the cooling objects 23 and 24 in drawing 2 , respectively. In addition, although the bis-stop of the resistor 33 is carried out also to the side of the cooling object 22, since the cross-section structure is shown about the cooling object 22, illustration has been omitted about the resistor 33.

[0012] The ebullition cooling system 20 consists of the interconnecting tubes 26-28, the liquid return pipes 29-31, and the cooling objects 22-24 containing the common condenser 25 and a bellows gaseous-phase pipe. The refrigerant which evaporated by performing heat exchange between atmospheric air is made to condense, it liquefies, and the common condenser 25 is stored in the interior. By a diagram, it has omitted about the radiator built in the common condenser 25. The cooling objects 22-24 begin to delete the metal block of copper or a copper alloy, aluminum, etc. to a core box by machining, have many the fins and diaphragms for thermolysis in the interior, and have composition which stores a refrigerant there. Conductive refrigerants, such as an ethylene glycol aqueous solution, are used for this refrigerant. Therefore, between the common form power semiconductor devices 10 and 12 and the cooling objects 22-24, the ALN boards 14-17 for an insulation are inserted. When using insulating refrigerants, such as chlorofluocarbon and fluorocarbon, for a refrigerant, these ALN boards 14-17 can be omitted.

[0013] The cooling objects 22-24 and the common condenser 25 are connected by interconnecting tubes 26-28 and the liquid return pipes 29-31. Interconnecting tubes 26-28 and the liquid return pipes 29-31 have double pipe structure, and the refrigerant which carried out heating ebullition and which was evaporated with the cooling objects 22-24 goes up between the interconnecting tubes 26-28 of an outside pipe, and the liquid return pipes 29-31 of an inside pipe, and is led to the common condenser 25. The bellows gaseous-phase pipe formed in a part of interconnecting tubes 26-28 absorbs expansion and contraction of each part by the temperature change. In addition, the insulating tube for insulating between the cooling objects 22-24 and the common condensers 25 besides a bellows gaseous-phase pipe may be formed in the middle of interconnecting tubes 26-28. In addition, in drawing, the cross-section structure is shown about the cooling object 22 and the interconnecting tube 26, and other cooling objects 23 and 24 and interconnecting tubes 27 and 28 also have same structure.

[0014] The pyrexia from the common form power semiconductor devices 10 and 12 is transmitted to the cooling objects 22-24 through the ALN boards 14-17, and the pyrexia from resistors 33-35 is transmitted to the direct cooling objects 22-24. With the cooling objects 22-24, with these heat, a refrigerant boils and it evaporates. The vaporized refrigerant goes up between the interconnecting tubes 26-28 of an outside pipe, and the liquid return pipes 29-31 of an inside pipe, is led to the common condenser 25, and is liquefied there. The liquefied refrigerant is temporarily stored in the common condenser 25, falls on the cooling objects 22-24 through the liquid return pipes 29-31, and returns. Thus, the ebullition cooling system 20 boiled the refrigerant at the cooling objects 33-35, was evaporated, and has controlled the temperature rise of the common form power semiconductor devices 10 and 12 and resistors 33-35 by making it liquefy with the common condenser 25.

[0015] In addition, copper or a copper alloy constitutes the cooling objects 22-24 from the gestalt of this operation. Conventionally, since the cooling object which constitutes the ebullition cooling system 20 did not have constraint of a material, it gave priority to the cost side and the manufacturing-technology side, and constituted them from iron or stainless steel. And in order to raise the degree of vacuum-proof of the ebullition cooling system 20, the material of a cooling object was thickened. Therefore, even if a part with a thick material and thermal conductivity were bad and it prepared the resistor in the side of a cooling object, cooling effectiveness was bad and had to enlarge capacity of a resistor as a result. on the other hand, the quantity of heat generated by resistors 33-35 by vapor cooling effectiveness becoming good in order that the cooling object made from copper or a copper alloy may show good heat conduction -- the cooling object made from copper or a copper alloy -- minding -- the refrigerant inside a cooling object -- easy -- transmitting -- there -- thermolysis -- and vapor cooling comes to be carried out. By this, the component diffused inside a case among the quantity of heat generated by resistors 33-35 can be reduced sharply, and the miniaturization of reduction of case surface areas and the whole electronic equipment can be realized as a result. Moreover, when the

resistor was being used with natural-convection-cooling cooling system like before, it is resistor capacity = generating quantity-of-heat x4-5, and the big resistor had to be used compared with the actual generating quantity of heat of a resistor. By having made the resistor into the forced-cooling (vapor cooling) method from natural-convection-cooling cooling system like this invention, it serves as resistor capacity = generating quantity of heat, can miniaturize the resistor itself, and can also aim at now improvement in that assembly nature.

[0016] In addition, although the gestalt of above-mentioned operation explained to the example the semiconductor stack which consists of layered products of a common form power semiconductor device and a cooling object as the stack structure, it is applicable not only like this but the electronic equipment cooling system which constitutes each stack, such as semiconductor stacks other than this, a diode rectifier stack, and a solid state switch stack. Moreover, although the gestalt of above-mentioned operation explained the individual cooling system which cools a heating element according to an individual to the example, it is applicable similarly [in the case of package cooling system]. Although the gestalt of above-mentioned operation explained the case where a semiconductor stack was constituted by two common form power semiconductor devices 10 and 12 and three cooling objects 22-24, it is applicable also like the semiconductor stack which consists of the common form power semiconductor devices and cooling objects of the number beyond this. Although the interconnecting tube was returned with the gaseous-phase pipe and the case of the double pipe structure of a pipe was explained to the example with the gestalt of above-mentioned operation, it is applicable also like what returned with the gaseous-phase pipe and has arranged the pipe separately.

[0017] Although the gestalt of above-mentioned operation explained the case where a resistor was prepared in the single-sided side of a cooling object, as long as it is except the part in contact with a semiconductor device, a resistor may be prepared in the both-sides side of a cooling object, the bottom, the bottom, etc. Furthermore, although the gestalt of above-mentioned operation explained the case where a resistor was prepared in the cooling object which constitutes a semiconductor stack, the cooling object of the dedication for cooling, the cooling object, i.e., the resistor, which does not constitute a semiconductor stack, is established separately, and you may make it connect it to the common condenser 25 with an interconnecting tube and a liquid return pipe. In this case, since a cooling object does not take the stack configuration by which pressurization contact is carried out, although it makes a material comparatively thin, it can be made, and can give priority to cooling effectiveness.

[0018]

[Effect of the Invention] According to the electronic equipment cooling system of this invention, it is effective in the ability to reduce the generating quantity of heat of the resistor emitted to a case building envelope as much as possible.

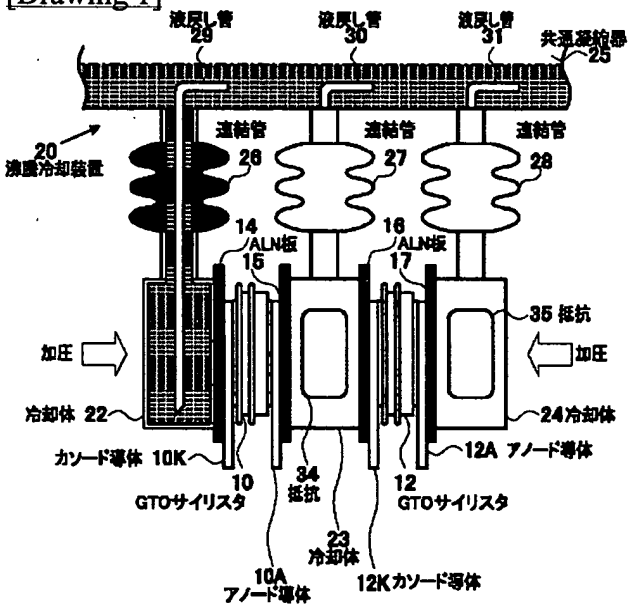
[Translation done.]

* NOTICES *

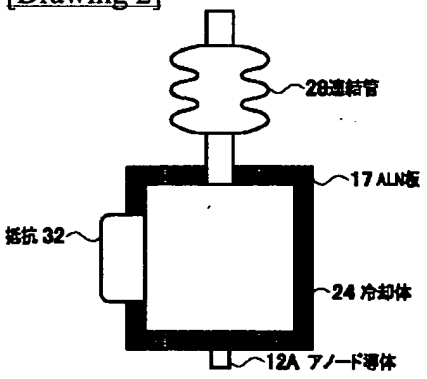
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]